

**Before the  
Federal Communications Commission  
Washington, D.C. 20554**

In the Matter of

Facilitating Opportunities for	)	
Flexible, Efficient, and Reliable	)	
Spectrum	)	ET Docket No. 03-108
Use Employing Cognitive Radio	)	
Technologies	)	

**PETITION FOR RECONSIDERATION  
  
OF  
  
MARCUS SPECTRUM SOLUTIONS**

In accordance with the provisions of 47 CFR §1.429 Marcus Spectrum Solutions (MSS) petitions for reconsideration of the Report and Order<sup>1</sup> in this proceeding, adopted March 10, 2005. MSS<sup>2</sup> is an independent consulting firm specializing in spectrum technology and policy issues. In this petition MSS is acting in the public interest, not on behalf of a specific client. The Commission is aware of the qualifications<sup>3</sup> of Dr. Michael J. Marcus, Director of MSS.

**I. SUMMARY**

This is a very complex proceeding dealing with a technology, cognitive radio, which is not yet on the market. It also deals with a related technology, software defined radio, which has recently had its first equipment authorization. In such cases, one can not expect all parties to agree nor

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<sup>1</sup> Published at 70 FR 23039, May 4, 2005.

<sup>2</sup> See [members.aol.com/marcusspectrum](http://members.aol.com/marcusspectrum)

<sup>3</sup> See [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/DOC-243463A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-243463A1.pdf)

should one expect a perfect decision from the Commission. However, after much thought MSS concludes that some of the flaws of this R&O are so great as to require near term attention. In particular, there are two important topics where there is ambiguity as to what policy change, if any, has been adopted. While the R&O was clearly intended to encourage the development of promising software defined radio and cognitive radio technologies, these ambiguities may end up having the unintended affect of delaying development but adding another risk element, “regulatory risk”, for potential investors in this technology.

This reconsideration request specifically deals with 3 of the subtopics of the R&O: 1) source code software submissions to the Commission, 2) digital-to-analog converter issues, and 3) amateur radio service SDR equipment authorization. There are many other issues in the R&O and MSS finds the Commission’s treatment of them reasonable. However, for reasons stated below, MSS finds that these 3 topics need at the very least clarification and probably need some fine tuning of the codified rules.

## II. SOURCE CODE SOFTWARE SUBMISSIONS

Para. 63 starts very clearly on this issue stating,

As described below, we are eliminating the rule that a manufacturer supply radio software (source code) to the Commission upon request because such software is generally not useful for certification review and may have become an unnecessary barrier to entry.

And, indeed, the present §2.944<sup>4</sup> is replaced with new text dealing with other issues. However, at 4 different places in the R&O this deletion is apparently negated by the recitation, using various wordings, of an apparently uncodified power, or at least an

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<sup>4</sup> Since there is some confusion about what the present rules is, the actual text is “§ 2.944 Submission of radio software.

The grantee or other party responsible for compliance of a software defined radio, or the applicant for authorization of a software defined radio shall submit a copy of the software that controls the radio frequency operating parameters upon request by the Commission. Failure to comply with such a request within 14 days or such additional time as the Commission may allow may be cause for denial of authorization, forfeiture pursuant to §1.80 of this chapter, or other administrative sanctions.”

Note that this did not require automatic submittal of source code, but enables the Commission to request it.

uncited power, of the Commission to continue to have the same authority which is being deleted in §2.944<sup>5</sup>.

MSS fully supports the deletion of the software submittal authority of §2.944. Source code, the original form of the software as written complete with comments explaining how each command works, is extremely valuable intellectual property and software firms usually go to extreme lengths to protect trade secret claims with respect to it. Indeed, the source code for a given product may contain code licensed from a third party under additional trade secret protections and thus can not be made public by the grantee without the payment of large fees to the original owner of the trade secrets. Furthermore, as Motorola points out, the source code is relatively useless in the equipment authorization process and the Commission is not presently staffed or equipped to effectively use it.

MSS fully agrees with the statement in Appendix C of the R&O, the Final Regulatory Flexibility Analysis which states in Section E that ,

“(The Commission) eliminated the requirement to supply software source code upon request because such software is not generally useful for certification review and may have become an unnecessary barrier to entry.”

However, the multiple recitations of contradictory language in the R&O cited in fn. 5 of this Petition seem to disagree with this outcome.

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<sup>5</sup> The specific locations and the text referred to is as follows:

fn. 4: “We always retain the right to request and examine any component (whether software or hardware) of a specific radio system when needed for certification under Commission rules.”

Para. 20 “We always retain the right to request and examine any component (whether software or hardware) of a specific radio system when needed for certification under Commission rules.”

Para. 39 “In addition, the Commission already has authority to request to request and examine any component (whether software or hardware) of a radio system when needed for certification under Commission rules.”

Para. 67 “In the event that questions arise about the compliance of a particular device, the Commission has the authority to request and examine any component (whether software or hardware) of a radio system when needed for certification under Commission rules without the need for a specific requirement to submit radio software.”

Deleting a requirement and then reinstating it in parenthetical remarks in the text of the R&O just creates ambiguity and confusion. Uncertainty about the security of the source code creates large investment risks for the developers of SDR software. This in turn could hinder capital formation for this promising new technology. All the commenters, except Cingular/Bellsouth, support deleting the requirement.

● MSS urges the Commission to decide explicitly whether it has deleted the requirement or not and to make sure the codified rules reflect its decision.

● Should the Commission decide that some sort of submission requirement is still necessary, MSS urges the Commission to codify whatever the requirement is and to take two reasonable steps to increase the confidence of developer and their investors that their intellectual property will not be compromised inadvertently at FCC:

1. Amend the new §0.457(d)(1)(ii) to state explicitly that any source code that made be requested is also a “record not routinely available for public inspection”
2. Amend the Commissions internal operating procedures on handling sensitive material to specify that such source code be given handling protections in processing within the Commission consistent with the value of the software source code. Fox example, the same handling protections as the most sensitive Commission draft agenda items and other sensitive proprietary information such as financial data related to mergers.

### III. DIGITAL-TO-ANALOG CONVERTER ISSUES

The NPRM proposed possible regulation of high speed, high power digital-to-analog (D/A) converters in para. 91-92:

(91) At present there is a clear distinction between radio transmitter technology, regulated under Section 2.801(a) of our rules and various radio service rules, and personal computer technology, regulated in a much less restrictive way under Subpart B of Part 15 of our rules. However, increasing computer speeds and speeds of digital-to-analog converters (DAC)<sup>6</sup> may well blur this distinction. A general purpose computer capable of outputting digital samples at rates in the million sample/seconds range or higher could be connected to a general purpose high-power, high-speed DAC card which could effectively function as a radio transmitter. The marketing of such computers, DACs, and software to make them interact could

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<sup>6</sup> The common personal computer sound card uses a low speed DAC, typically about 40,000 samples/second, to produce audio output.

undermine our present equipment authorization program at the risk of increasing interference to legitimate spectrum users since none of them would be subject to the normal authorization requirements. At present this is not a problem, but we wish to consider modest steps now to help ensure that this scenario does not become a serious problem.

(92) While such high-speed DACs are presently marketed to the scientific community at high unit costs, we are not aware of any which are marketed as consumer items. We seek comment on whether we need to restrict the mass marketing of high-speed DACs that could be diverted for use as radio transmitters and whether we can do so without adversely affecting other uses of such computer peripherals or the marketing of computer peripherals that cannot be misused. We seek comment on one possible approach as well as welcoming alternative proposals. Would it make sense to require that digital-to-analog converters marketed as computer peripherals that 1) operate at more than one million digital input samples/second, 2) have output power levels greater than 100 mW and, 3) have an output connector for the analog output be limited in marketing to commercial, industrial and business users as we require for Class A digital devices? Would it be preferable to characterize such systems in terms of output frequency and bandwidth rather than input sampling rate? What sampling rate and power limits would be needed to avoid impacting DACs that might have a legitimate consumer use such as, for video systems and other media applications? Is there a practical way to incorporate security features that would limit the frequency range or other operating parameters of these devices? We also seek comment on the specific types of devices that would be affected and the potential burden on manufacturers.

Several parties objected to this proposal. For reference, their relevant comments are included in Appendix I herein. Frankly, it appears that most of the commenters never read para. 91-92 carefully and are focused on concerns not related to the proposal. Para. 92 specifically discusses limiting and regulation to several conditions: samples rate greater than one million samples/sec, power levels greater than 100 mW, and output connectors typical of antennas. Such conditions would affect none of the D/A converters on the market at present<sup>7</sup>. No manufacturer or dealer of similar D/A converters objected to the proposed regulation. None of the commenters presented any arguments why D/A converters meeting such conditions might have a legitimate market for the general public.

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<sup>7</sup> Typical presently marketed high speed D/A converters are described at the following websites:

<http://www.echotek.com/ECAD-DA-41-PMC.asp>

<http://www.analog.com/en/prod/0%2C%2CAD5450%2C00.html>

[pdfserv.maxim-ic.com/en/an/A5003.pdf](http://pdfserv.maxim-ic.com/en/an/A5003.pdf)

<http://www.drs.com/products/index.cfm?gID=17&productID=424>

<http://www-s.ti.com/sc/ds/dac5672.pdf>

Intel, ITI and Raytheon, seem to be concerned about any expansion of the Commission's regulation in the digital device area regardless of its impact with respect to interference protection.

Cisco predicts that "these cases would be few in number and could easily be handled using the Commission's existing enforcement powers." Cisco and others assume that hardware manufacturers are all mainstream benevolent firms like themselves and similar members of major trade associations such as TIA and the SDR Forum. However, the reference in fn. 51 of the *Pilot Travel Centers* case should be a reminder that not all firms are so benevolent in their marketing approaches. There is a tier of manufacturers<sup>8</sup> and distributors who are ready and willing to fill market niches for illegal products like high power CB transmitters or, more dangerously, high power cordless phones that operate in safety-related bands such as aviation bands. The general challenge in spectrum policy is to find a regulatory approach that is reasonably likely to keep this tier in check while having little or no burden on mainstream firms which obey both the letter and spirit of the Commission's rules.

Dr. Marcus worked many years for Richard M. Smith, former head of the Commission's Field Operations Bureau (now part of Enforcement Bureau) and then Office of Engineering and Technology. Early in his career in the 1960s while in the Commission's Los Angeles office, Mr. Smith was charged with finding and turning off a large number of first generation garage door opener receivers. Prior to the adoption of §15.101(b) these were exempt from unintentional emission regulation but were, in fact, interfering with military aircraft. After Herculean efforts involving helicopter flights he succeeded in doing this but came away firmly convinced for the rest of his career that it is better to prevent such problems rather than to solve them. For the rest of his long distinguished career at the Commission Mr. Smith reminded colleagues of this viewpoint. In honor of Mr. Smith, MSS would like to remind the Commission also of this lesson.

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<sup>8</sup> While it might be tempting to assume that only large established "high tech" companies could construct and sell SDRs and high speed D/A converters, the firms cited in the previous footnote and not all Fortune 500 members. Indeed, several small amateur radio equipment manufacturers, e.g. Ten-Tec, ICOM, and Vertex Standard/YAESU. already sell *de facto* SDRs which only lack an explicit interface for changing the internal software and would otherwise meet the Commission's SDR definition. Repackaging a D/A converter to give it a standard PC interface and a typical antenna connector is a manufacturing job easily handled by small companies and is similar to repackaging internal PC components, such as disk drives, as stand alone external units.

ARRL claims that “restrictions on DAC technology would hinder amateur experimentation with local oscillators, test equipment and other legitimate uses”. They do not state why powers greater than 100 mW, which are not even presently available, are necessary for such experimental. Nor do they explain why limiting “mass marketing”, as has been done for years for Class A digital devices, would prevent hams from obtaining D/A converters through electronic parts distributors as they get many other parts.

MSS predicts that if high power, high speed D/A converters with antenna-like connectors are ever readily available to the general public through large retailers, e.g. Radio Shack, CompUSA, or Walmart, then the whole FCC equipment authorization program will be bypassed and third party providers will have an immediate market for software that will make computers with such converters into any type of illegal equipment you wish in any band you wish.

MSS predicts that Napster-like entities will market illicit, but not illegal under present FCC rules, software to individuals with PCs and such D/A converters to allow such individuals with no technical skills to emulate all sorts of illegal equipment presently kept off the market by present FCC rules.

It is ironic that CMRS and public safety interests in this proceeding have expressed alarm about cognitive/“smart” radio technology impinging into their spectrum but have not been farsighted enough to see the potential threat of such “dumb” radio abuses of high speed, high power D/A converters.

EFF’s comments are more substantive and focus on the possibility that someone with electronic skills could extract a D/A converter from a device such as a video card or even build a D/A converter. They do not argue that there is a legitimate mass market need for D/A converters with speeds greater than 1 million samples/second, powers greater than 100 mW, and an antenna-like connector. The intent of the Commission’s equipment authorization program is not to prevent all construction and use of illegal equipment, this is something dictatorships like the Soviet Union tried and failed at with significantly more resources than FCC. Rather, it is to prevent ready access and large scale use of illegal equipment. Skilled persons can build traditional radio transmitters today from parts that are available. But ready access to the components discussed in para. 92 means that someone with little or no skill could connect such a device to a PC connect an antenna to it, and use downloaded software to emulate any type of radio transmitter – for example an aviation band cordless telephone.

EFF also raises the specter that “a regulation over DACs will limit academic freedom, scientific inquiry, and turn the Commission into the de-facto

designer of many non-radio devices.” EFF does not explain how limiting sales to the general public would limit academic freedom as universities and laboratories would not be restricted at all. Nor does EFF explain how a very narrowly drawn regulation would make the Commission a “de-facto designer of many non-radio devices.” The proposal given in the next paragraph has been crafted to meet these concerns.

The R&O in para. 62 dismisses the possibility of D/A converter regulation with these words,

“No parties have provided any information that shows ... high-speed D/A converters present any significantly greater risk of interference to authorized radio services than hardware radios. Therefore, we decline to adopt any new regulations for ... D/A converters at this time.”

It is unclear where this logic came from. This is not a point raised in the NPRM nor in the comments. Hardware radios are regulated under present rules. Potentially harmful high power, high speed D/A converters can be legally marketed now without any regulation<sup>9</sup> as can software which turns them into, effectively, antisocial transmitters or jammers. **Imagine software that turns your PC into not only a police or aviation band scanner but lets you transmit in response to what you hear on the band!** While the traditional hardware version of this would clearly violate Subpart I of Part 2 of the Commission’s rules, the software and D/A converter version would not. While the members of TIA and SDR Forum clearly have no intention of marketing such products, the same rules have to apply to everyone and past experience shows that irresponsible small firms may well take advantage of such loopholes.

The Commission likes to talk about “convergence” as a positive trend. It generally is. But the above scenario is a very dark side of convergence in which the ubiquitous PC becomes an illegal radio. It can be prevented with a little bit of preemptive regulation that will impact no present or immediately foreseeable products.

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<sup>9</sup> Except for the unintentional radiator limits of Part 15, Subpart B which would not affect the ability to use such a device as a *de facto* transmitter



● MSS urges the Commission to issue a Further Notice of Proposed Rulemaking on the issue of D/A converters as opposed to lack of action in the R&O. The FNPRM should propose a very narrowly drawn rule that would only cover D/A converters that met all these qualifications:

- 1) have sample speeds in excess of 1 million samples/sec<sup>10</sup> *and*
- 2) have output power greater than 1 Watt *and*
- 3) have an interface for receiving the digital input to the D/A converter which is interoperable with widely available Class B personal computer systems (*e.g.* USB and Firewire) *and*
- 4) have an analog output for the converted signal which is compatible in both connector type and approximate impedance with widely available antennas (*e.g.* BNC)

D/A converters meeting all these characteristics would then be classified as Class A digital devices automatically and their marketing to the general public as standalone endproducts would be prohibited. However, they could be included as internal components of broader systems that did not meet the 4 point test. And they could be sold through specialized channels such as the market for electronic test equipment<sup>11</sup>.

This narrowly drawn proposal would prevent the mass marketing of products that could be readily converted to illicit transmitters with no technical skill. It meets the objection raised in most of the comments, other than those of Intel and ITI who object to any new regulations of digital devices. It would not affect any product presently on the market or any product that has been discussed for possible marketing.

The concept of basing regulations on types of interfaces to other equipment is not without problems, however, it is not new either. §15.203 already treats different types of antenna connectors differently. Experience shows that the types of connectors available for certain functions changes over times. In the case of §15.203 the staff has kept up with such evolution without the need for rulemaking and the same could be done here.

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<sup>10</sup> The maximum frequency fundamental a D/A converter can generate is half the sampling rate. This proposed sampling rate can generate fundamentals frequencies of 0.5 MHz, or 500 kHz, capable of sending signals in the AM broadcast band.

<sup>11</sup> The Commission has traditionally allowed the marketing of specialized test equipment such as broadband linear amplifiers, GPS signal simulators, and cellular base station simulators through specialized dealers and distributors to limited markets without equipment authorization.

There certainly will be entities opposed to such modest and narrowly limited regulation. MSS urges them to state explicitly what socially responsible products will be impacted by such a rule. MSS urges the Commission to ponder what a world with high speed radio frequency D/A converters readily connectable to ubiquitous PCs and commonly marketed antennas with unregulated software downloads available more easily than pirated music would be like. In this case, truly, an ounce of prevention is worth a pound of cure.

#### IV. AMATEUR RADIO SDR ISSUES

Before this R&O the status of amateur radio transmitters with respect to equipment authorization and marketing in the US was clear: They were exempt from all such rules adopted under the Commission's 47 USC §302 authority except in the special case of transmitters and amplifiers capable of operating near the 27 MHz Citizens Band<sup>12</sup>. With this R&O the status of such equipment is less clear and the resulting ambiguity could well have unintended negative consequences. This is important to both the Amateur Radio Service as well as the US electronic industry in general.

Why "the US electronic industry"? The fundamental purpose of the amateur service stated in §97.1 and three of the principals are stated as:

§97.1(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

§97.1 (c) Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art.

§97.1 (d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts. (Emphasis added)

Many of today's leaders in the US electronics industry had their initial interest in this area stimulated through the amateur radio service and the then cutting edge radio technology that it used. 30+ years ago it was possible for amateurs to build and modify cutting edge equipment themselves and this was very attractive to young people. Sadly, such hardware construction with today's technology is very difficult for the novice due to the higher frequencies and more complex modulations in use.

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<sup>12</sup> See §2.815 and §2.1060. These are relics of a period around 1970 when CB problems were a major national issue and a focus of much FCC activity.

Dr. Marcus, of MSS, has published a vision of how amateur radio use and experimentation with SDR could both bring experimentation back to the amateur radio service and also develop young people with the very skills that today's electronic industry wants: programming of the digital signal processing which is key to SDR. His vision was published in the ARRL's monthly magazine, *QST*, and was voted by the readers as the best article in that issue.<sup>13</sup> A copy of this article is also being inserted into the record of this proceeding.

The *QST* article describes a path of how amateurs could use SDR technology to experiment and share ideas and developments much more quickly than was possible in the "golden age" of hardware radios. These developments could advance radio technology and develop the types of skills envisioned in §97.1(d) that are essential if the US electronics industry is to remain competitive.

While the R&O adopted no new rules explicitly concerning amateur radio and SDRs, the last sentence of para. 62 contains the following words:

However, we note that certain unauthorized modifications of amateur transmitters are unlawful, (fn. 90) and may revisit both of these issues in the future if misuse of such devices results in significant interference to authorized spectrum users.

The phrase "certain unauthorized modifications" is never explained in the R&O. Can an amateur radio licensee change the software in a commercially marketed radio, such as the ICOM IC-7800, just as he could modify the hardware of previous generations of radios? Does it matter whether or not ICOM condoned or enabled such modification? Does the modification by an amateur radio licensee illegal as long as he doesn't market the radio or use it on a frequency for which he is not licensed<sup>14</sup>?

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<sup>13</sup> Mike Marcus, N3JMM/7J1AKO, "Linux, Software Radio and the Radio Amateur", *QST*, October 2002, p. 33-35 (Dr. Marcus was not identified as an FCC employee in this article)

<sup>14</sup> Until about 25 years ago an amateur transmitter's specific frequency was controlled by either individual crystals (one for each frequency used) or analog variable frequency oscillators (VFOs). Such transmitters by their very nature covered more than the allocated amateur radio service bands. The frequency was controlled by the licensee by either selecting the crystal to be used or adjusting the VFO. Equipment manufacturers were unable to limit the frequency range tightly and the Commission had no expectation that they do so. With the appearance of low cost indirect frequency synthesizer technology about 25 years ago it became possible to control frequencies tightly at time of manufacture. In enforcement actions the Commission has asserted the power to limit amateur radio transmitters strictly to

Fn. 90 refers to para. 44 and fn. 53, although informal discussions with the FCC staff indicates that this was intended to read para. 42 and fn. 51. In para. 42 it is stated that

However, the Commission has held that a hardware-based device that can easily be altered to activate a capability of operating in additional frequency bands is subject to equipment certification under the rules that apply in those bands prior to marketing or importation.

Is an amateur radio SDR with software that can be changed by the user a “hardware-based device that can easily be altered to activate a capability of operating in additional frequency bands” and hence subject to equipment authorization?

It would appear that an amateur radio SDR would also be covered by the new §2.944(b),

Any radio in which the software is designed or expected to be modified by a party other than the manufacturer and would affect the operating parameters of frequency range, modulation type or maximum output power (either radiated or conducted), or the circumstances under which the transmitter operates in accordance with Commission rules, must comply with the requirements in paragraph (a) of this section and must be certified as a software defined radio. (Emphasis added.)

Thus while para. 62 of the R&O appears to avoid adopting regulatory requirements, it brings new types of amateur radio equipment into equipment authorization for the first time. The *increased and uncertain burdens* imposed on amateur equipment manufacturers, generally small businesses, by both the new §2.944(b) and the new broad interpretation of the *Pilot Travel Center* case<sup>15</sup> will most likely discourage any new amateur radio equipment manufacturers from introducing SDRs in which users have any access to the software within the radio. This will reverse 70 years of FCC regulation of amateur radio in which amateurs were allowed and encouraged to tinker with their equipment. While there might be public interest benefits from such a change, there is clearly nothing in the NPRM or the record to

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allocated bands although this issue has never been codified. Indeed, the arrival of indirect frequency synthesizer technology has raised several issues in equipment design and the only place these have been addressed in rulemaking is in §90.203(e) and (g) which are not relevant in the instance of amateur radio.

<sup>15</sup> See *In the Matter of Pilot Travel Centers, L.L.C., Knoxville, Tennessee, Notice of Apparent Liability for Forfeiture*, 19 FCC Rcd 23113, 23114 (2004). Note that this was an enforcement proceeding *not* a notice and comment rulemaking..

justify it. Indeed, one has to parse carefully the R&O to see what was even done!

Finally, the outcome is at odds with the Final Regulatory Flexibility Analysis in Appendix C which states in Section E that “the Commission simplified the filing requirements for software defined radios to benefit all entities, including small entities.” There is no hint that regulation is expanded to cover a new class of amateur radio equipment.

● MSS suggests to the Commission that it either

- a) return to the *status quo ante* and keep all amateur radio equipment out of equipment authorization except for the longstanding exception<sup>16</sup> of equipment operating near the 27 MHz CB band or
- b) explicitly make amateur radio SDR equipment subject to equipment authorization and the requirements of the new §2.944 in a notice and comment rulemaking, such as a further NPRM, with a provision for a “safe harbor” without equipment authorization if there are hardware provisions or nonuser changeable software that controls the frequency bands of transmissions.

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<sup>16</sup> Although still a sore point in much of the amateur radio community.

## V. CONCLUSIONS

MSS recommends changes in the R&O as stated above in the areas of source code software submissions to the Commission, digital-to-analog converter issues, and amateur radio use of SDR. While the clear intent of the R&O was to encourage SDR and cognitive radio technology, the ambiguities identified above are likely to slow progress. Specific suggestions have been made above to show how the R&O might be modified.

Michael J. Marcus, Sc.D., FIEEE  
Director  
Marcus Spectrum Solutions  
55, rue Molitor  
F-75016 Paris France  
[mjmarcus@alum.mit.edu](mailto:mjmarcus@alum.mit.edu)  
[members.aol.com/marcusspectrum](http://members.aol.com/marcusspectrum)

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## **APPENDIX I: COMMENTS ON D/A CONVERTER ISSUES**

(In alphabetical order)

### **ARRL**

Current Part 2 and Part 97 rules prohibit the use of any external amplifiers capable of the gain necessary to pose any serious interference threat - when coupled with 100-mW exciters. Restrictions on DAC technology would hinder amateur experimentation with local oscillators, test equipment and other legitimate uses. ARRL believes that such interference, should it ever occur, would best be addressed within existing FCC regulations as an enforcement issue and that further regulation is unnecessary. Therefore, it is recommended that no restrictions on DAC technology be implemented by the Commission with respect to the Amateur Service.

### **Cisco**

The Notice also asks whether higher power, high speed digital-to-analog converters could operate as radio transmitters and how the Commission's rules should be amended to prevent unauthorized use and harmful interference. We understand the Commission's concern that a generic, software-controlled digital-to-analog converter card could be configured by some remote users to operate on a frequency band not approved by the Commission.<sup>23</sup> However, these cases would be few in number and could easily be handled using the Commission's existing enforcement powers.

### **EFF**

If PCs shouldn't be regulated, then how should the Commission ensure that the airwaves aren't overrun by bad actors spewing noise or even intentional interference through PC-based emitters? The current Notice asks if the proper regulation should be over DACs, for without these, a PC is mute -- they're the voice box through which bits are converted to analog radiowaves.<sup>16</sup> Such a regulation could be tailored to just DACs embedded in boards intended for use as SDRs, but this would not be effective. A VGA video-card contains DACs that can be readily repurposed to turn a PC into a tuneable emitter. But regulation of DACs is problematic. The world is filled with DACs: There are far more DACs in the field than human beings. These are so widespread that it is a certainty that deliberate malefactors will not have any trouble acquiring a DAC regardless of the regulatory landscape. o DACs are easy to make: undergraduates in Electrical Engineering programs are frequently assigned the task of making a fast DAC out of a few

resistors. A 1 GHz DAC can be built for a few dollars from parts. Even if the installed base of DACs were somehow brought under regulation, the ability of a moderately skilled badguy to make her own DACs can't be likewise checked.

o DACs are everywhere, and a regulation over DACs will limit academic freedom, scientific inquiry, and turn the Commission into the de-facto designer of many non-radio devices.

## **Intel**

Finally, Intel strongly opposes any restriction on the mass marketing of high-speed DACs such as limiting marketing to commercial, industrial and business users as required for Class A digital devices. These devices do not represent a risk and such a restriction would represent a dangerous expansion of the regulation of the PC industry.

## **ITI**

In addressing the issue of digital-to-analog converters (DACs), ITI understands that the Commission may have concerns regarding a DAC card with unauthorized software being configured by a remote user to operate on a frequency band not approved by the Commission. However, ITI does not believe that DACs, alone, represent a significant risk. By restricting them, the FCC would set a dangerous precedent in applying intentional radiator rules to unintentional radiator devices. This would create an undue regulatory burden on manufacturers and result in increased costs for consumers. Therefore, ITI strongly opposes the Commission's proposal in paragraph 92 of the Notice to restrict the mass marketing of high-speed DACs.

## **Raytheon**

(Listed in ECFS as "Scott Seidel", the Raytheon employee who signed the comments))

Concerning regulation of computer technology, we believe existing rules and regulations are adequate. No new rules or regulations regarding unintentional emissions



are needed in this area.

